# 1. Introduction

Because of concerns with the growing threat of global climate change from increasing concentrations of greenhouse gases in the atmosphere, more than 176 countries (as of Oct. 7, 1998) have become Parties to the U.N. Framework Convention on Climate Change (FCCC) (UNEP/WMO 1992). The FCCC was entered into force on March 21, 1994, and the Parties to the FCCC adopted the Kyoto Protocol for continuing the implementation of the FCCC in December 1997 (UNFCCC 1997). The Protocol requires developed countries to reduce their aggregate emissions by at least 5.2% below 1990 levels by the 2008-2012 time period.

The Kyoto Protocol requires Annex I (developed) countries to report anthropogenic emissions by sources, and removals by sinks, of greenhouse gases at the national level (Article 5).[1] For example, countries would have to set national systems for estimating emissions accurately, achieving compliance with emissions targets, and ensuring enforcement for meeting emissions targets. Annual reports on measurement, compliance and enforcement efforts at the national level would be required and made available to the public.

The Kyoto Protocol includes two project-based mechanisms for activities across countries. Article 6 of the Protocol allows for joint implementation projects between Annex I countries: i.e., project-level trading of emissions reductions ("transferable emission reduction units") can occur among countries with GHG emission reduction commitments under the Protocol. Article 12 of the Protocol provides for a "Clean Development Mechanism" (CDM) that allows legal entities in the developed world to enter into cooperative projects to reduce emissions in the developing world for the benefit of both parties. Developed countries will be able to use certified emissions reductions from project activities in developing countries to contribute to their compliance with GHG targets. Projects undertaken by developed countries will not only reduce greenhouse gas (GHG) emissions or sequester carbon, but may also result in non-GHG benefits and costs (i.e., other environmental and socioeconomic benefits and costs). The key provisions of the Kyoto Protocol remain to be developed in more detail as negotiations clarify the existing text of the Protocol.[2]

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[1] GHG sources include emissions from fossil fuel combustion, industry, decomposing and oxidized biomass, soil carbon loss, and methane from agricultural activities, livestock, landfills and anaerobic decomposition of phytomass. GHG sinks include storage in the atmosphere, ocean uptake, and uptake by growing vegetation (IPCC 1995; Andrasko et al. 1996).

[2] While the this report focuses on the Kyoto Protocol, it should also be useful for projects undertaken before the Protocol goes into effect: e.g., in the US, the President's Climate Change Proposal contains a program that rewards organizations, by providing credits or incentives (e.g., a credit against a company's emissions or a tax credit), for taking early actions to reduce greenhouse gases before the international agreements from the Kyoto Protocol would take effect. The proposal is now commonly referred to as a "credit for early action" program (USGAO 1998).

## 1.1. Overview of Project Tasks

Energy-efficiency projects to be undertaken within the Clean Development Mechanism or under joint implementation will likely involve several tasks (Fig. 1.). The guidelines contained in this report are primarily targeted to the tasks that occur during the implementation of a project (see section numbers in Fig. 1). The project design and development phase will incorporate many of the information needs required for completing the later tasks (see Section 3). We expect that there will be different types of arrangements for implementing these projects: e.g., (1) a project developer might implement the project with his/her own money; (2) a developer might borrow money from a financial institution to implement the project; (3) a developer might work with a third party who would be responsible for many project activities; etc. While the flow of funds might change as a result of these different arrangements, the guidelines presented in this report should be relevant to all parties, independent of the arrangement.

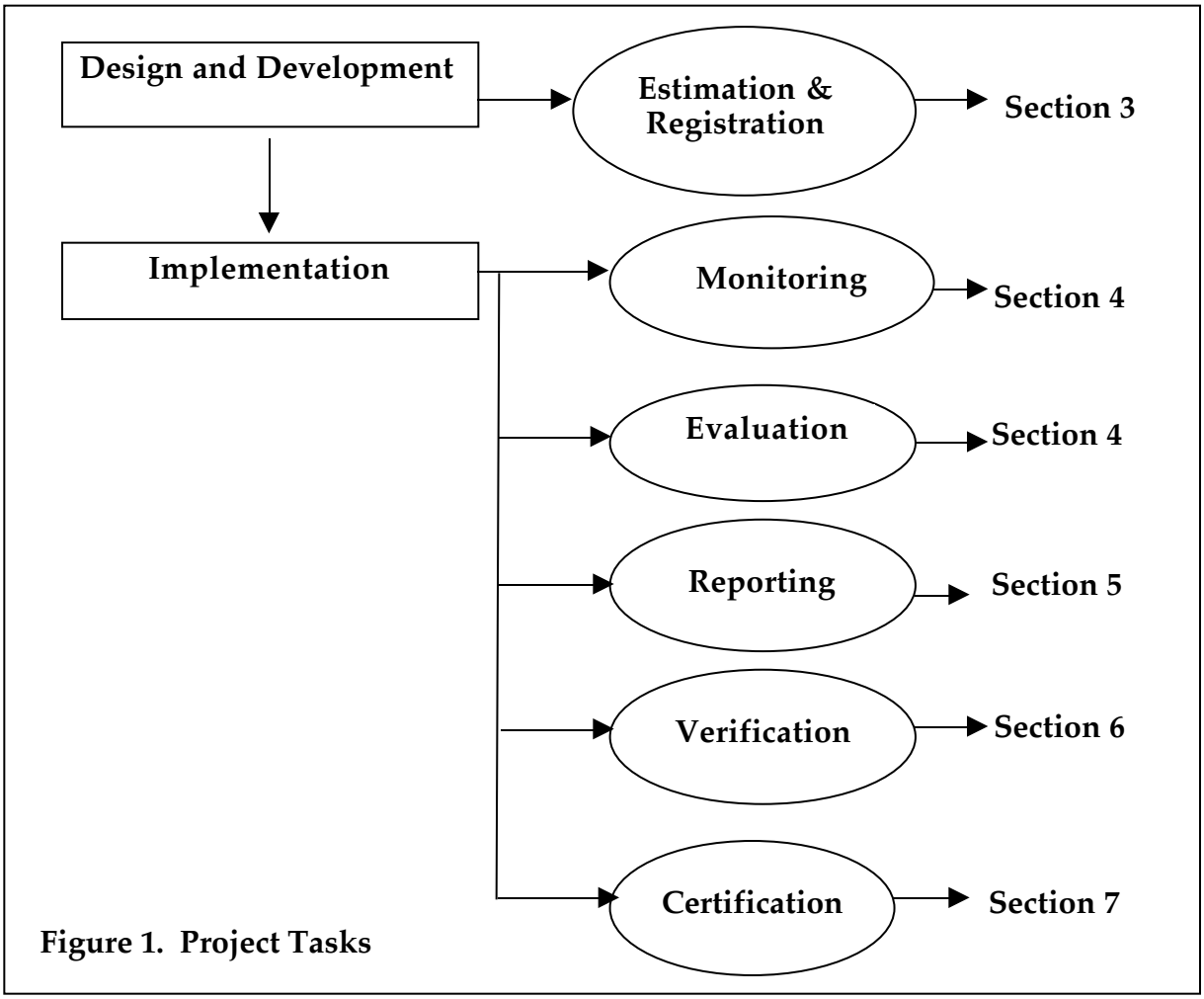



**Figure 1. Project Tasks**

In Figure 1, we differentiate "registration" from "certification" (see Section 7). Certification refers to certifying whether the measured GHG reductions actually occurred. This definition reflects the language in the Kyoto Protocol regarding the Clean Development Mechanism and "certified emission reductions." In contrast, when a host country approves a project for implementation, the project is "registered" (see UNFCCC 1998b).[1] For a project to be approved, each country will rely on project approval criteria that they developed: e.g., (1) the project funding sources must be additional to traditional project development funding source; (2) the project must be consistent with the host country's national priorities (including sustainable development); (3) confirmation of local stakeholder involvement; (4) confirmation that adequate local capacity exists or will be developed; (5) potential for long-term climate change mitigation; (6) baseline and project scenarios; and (7) the inclusion of a monitoring protocol (see Watt et al. 1995).

A country may also use different administrative or legal requirements for registering projects. For example, the project proposal (containing construction and operation plans, proposed monitoring and evaluation of energy savings and emissions, and estimated energy savings and emissions) might have to be reviewed and assessed by independent reviewers (see Section 3). After this initial review, the project participants would have an opportunity to make adjustments to the project design and make appropriate adjustments to the expected energy savings and emissions. The reviewers would then approve the project, and the project would be registered.[2] Individuals or organizations voicing concerns about the project would have an opportunity to appeal the approval of the project, if desired.

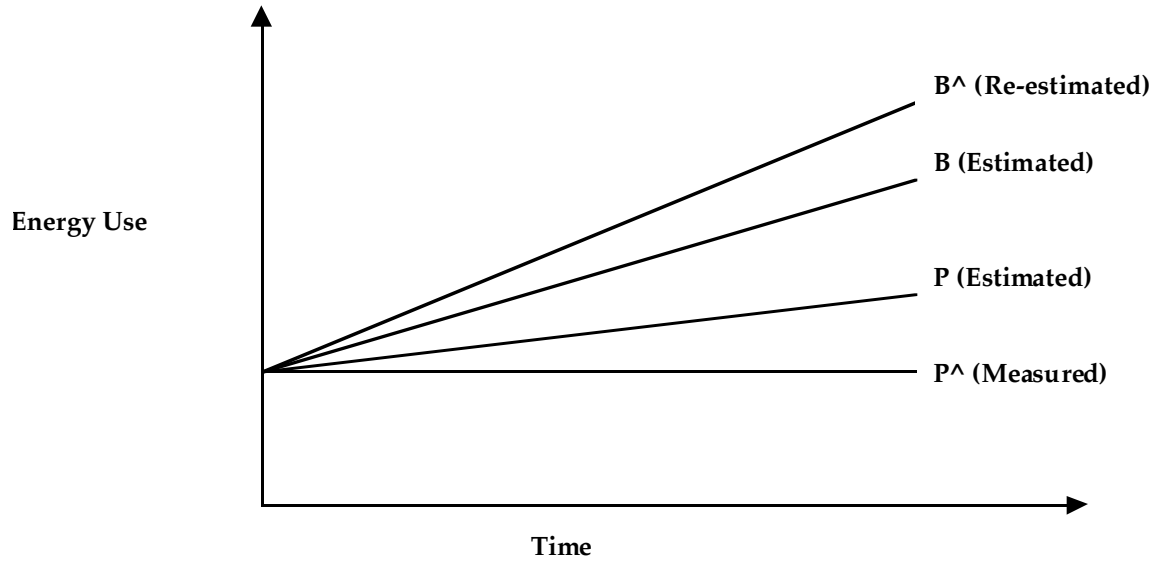
## 1.2. Conceptual Framework

The analysis of energy use occurs when a project is being designed and during the implementation of an energy-efficiency project. In the design stage, the first step is estimating the baseline (i.e., what would have happened to energy use if the project had not been implemented) (see Section 3.2) and the project impacts. Once these have been estimated, then the net energy savings are simply the difference between the estimated project impacts and the baseline (P-B, in Fig. 2). After a project has started to be implemented, the baseline can be re-estimated and the project impacts will be calculated based on monitoring and evaluation methods (Section 4). The net savings will be the

[1] In contrast to our interpretation, others believe certification occurs at the project approval stage, prior to implementation. We disagree, since certification can only occur after energy savings have been measured.

[2] Under this approach, the independent reviewers could be the same people who verify the project during project implementation (personal communication from Johannes Heister, The World Bank, Jan. 12, 1999).

difference between the measured project impacts and the re-estimated baseline (P^-B^, in Fig. 2). The example in Fig. 2 illustrates a case where measured energy use is lower than estimated as a result of an energy-efficiency project. On the other hand, energy use in the re-estimated baseline is higher than what had been estimated at the project design stage. In this case, the calculated net energy savings (P^-B^) is larger than what was first estimated (P-B).




**B: Estimated energy use without project (baseline)**
**P: Estimated energy use with project**
**P-B: Estimated net (additional) energy savings**

**B^: Re-estimated energy use without project (baseline) (after monitoring and evaluation)**
**P^: Measured energy use with project (after monitoring and evaluation)**
**P^-B^: Measured net (additional) energy savings (after monitoring and evaluation)**

**Figure 2. Example of Energy Use Over Time**

## 1.3. Purpose of MERVC Guidelines

Monitoring, evaluating, reporting, verifying, and certifying (MERVC) guidelines are needed for joint implementation and CDM projects in order to accurately determine their impact on GHG and other attributes (see Box 1) (Vine and Sathaye 1997). The estimation of project impacts is not the focus of the guidelines in this report; however, these guidelines do discuss many of the issues involved in estimation, since they are of utmost concern in the activities that occur after a project is implemented. Furthermore, the findings based on measurement and evaluation are often compared with the estimated impacts of a project.

Under joint implementation, the reduction in emissions by sources, or an enhancement of removals by sinks, must be "additional" to any that would otherwise occur, entailing project evaluation (Article 6) (see Section 3). And the "emission reduction units" from these projects can be used to meet Annex I Party's commitment under Article 3 of the Kyoto Protocol, necessitating all MERVC activities to be conducted. Similarly, under the Clean Development Mechanism, emission reductions must not only be additional, but certified, real and measurable, again requiring the performance of all MERVC activities (Article 12).

Implementation of standardized guidelines is also intended to: (1) increase the reliability of data for estimating GHG impacts; (2) provide real-time data so programs and plans can be revised mid-course; (3) introduce consistency and transparency across project types, sectors and reporters; (4) enhance the credibility of the projects with stakeholders; (5) reduce costs by providing an international, industry consensus approach and methodologies; and (6) reduce financing costs, allowing project bundling and pooled project financing.

These guidelines are important management tools for all parties involved in carbon mitigation. There will be different approaches ("models") in how the monitoring, evaluation, reporting, verification, and certification of energy-efficiency projects will be conducted: e.g., a project developer might decide to conduct monitoring and evaluation, or might decide to contract out one or both of these functions. Verification and certification must be implemented by third parties (Article 12). Similarly, some projects might include a portfolio of projects. Despite the diversity of responsibilities and project types, the Lawrence Berkeley National Laboratory's (LBNL's) MERVC guidelines should be seen as relevant for all models and project approaches.

**Box 1**

## Definitions

Estimation: refers to making a judgement on the likely or approximate energy use, GHG emissions, and socioeconomic and environmental benefits and costs in the with- and without-project (baseline) scenarios. Estimation can occur throughout the lifetime of the project, but plays a central role during the project design stage when the project proposal is being developed.

Monitoring: refers to the measurement of energy use, GHG emissions and socioeconomic and environmental benefits and costs that occur as a result of a project. Monitoring does *not* involve the calculation of GHG reductions nor does it involve comparisons with previous baseline measurements. For example, monitoring could involve the number of compact fluorescent lamps installed in a building. The objectives of monitoring are to inform interested parties about the performance of a project, to adjust project development, to identify measures that can improve project quality, to make the project more cost-effective, to improve planning and measuring processes, and to be part of a learning process for all participants (De Jong et al. 1997). Monitoring is often conducted internally, by the project developers.

Evaluation: refers to both impact and process evaluations of a particular project, typically entailing a more in-depth and rigorous analysis of a project compared to monitoring emissions. Project evaluation usually involves comparisons requiring information from outside the project in time, area, or population (De Jong et al. 1997). The calculation of GHG reductions is conducted at this stage. Project evaluation would include GHG impacts and non-GHG impacts (i.e., environmental, economic, and social impacts), and the re-estimation of the baseline, positive project spillover, etc. which were estimated during the project design stage (see Section 3). Evaluation organizes and analyzes the information collected by the monitoring procedures, compares this information with information collected in other ways, and presents the resulting analysis of the overall performance of a project. Project evaluations will be used to determine the official level of GHG emissions reductions that should be assigned to the project. The focus of evaluation is on projects that have been implemented for a period of time, not on proposals (i.e., project development and assessment). While it is true that similar activities may be conducted during the project design stage (e.g., estimating a baseline or positive project spillover), this type of analysis is estimation and not the type of evaluation that is described in this report and which is based on the collection of data.

Reporting refers to *measured* GHG and non-GHG impacts of a project (in some cases, organizations may report on their *estimated* impacts, prior to project implementation, but this is not the focus of this paper). Reporting occurs throughout the MERVC process (e.g., periodic reporting of monitored results and a final report once the project has ended).

Verification refers to establishing whether the measured GHG reductions actually occurred, similar to an accounting audit performed by an objective, certified party. Verification can occur without certification.

Certification refers to certifying whether the measured GHG reductions actually occurred. Certification is expected to be the outcome of a verification process. The value-added function of certification is in the transfer of liability/responsibility to the certifier.

LBNL's MERVC guidelines will help project participants determine how effective their project has been in curbing GHG emissions, and they will help planners and policy makers in determining the potential impacts for different types of projects, and for improvements in project design and implementation. Finally, by providing the basis for more reliable savings and a common approach to the measurement and evaluation of energy-efficiency projects, widespread adoption of the MERVC guidelines will make efficiency improvements more reliable and profitable.

In the longer term, MERVC guidelines will be a necessary element of any international carbon trading system, as proposed in the Kyoto Protocol. A country could generate carbon credits by implementing projects that result in a net reduction in emissions. The validation of such projects will require MERVC guidelines that are acceptable to all parties. These guidelines will lead to verified findings, conducted on an ex-post facto basis (i.e., actual as opposed to predicted project performance).

LBNL's MERVC guidelines have been reviewed by project developers (working on projects in Eastern Europe, Africa and Latin America) as well as experts in the monitoring and evaluation of energy-efficiency projects. The practitioners reviewed the report for accuracy and assessed whether data were available for completing the forms presented at the end of this report. Based on their feedback, we believe LBNL's guidelines can be used by project developers, evaluators, and verifiers. We hope that international entities can also use our guidelines as a model for developing official MERVC-type guidelines.

## 1.4. Target Audience

These guidelines are primarily for developers, evaluators, verifiers, and certifiers of energy-efficiency projects. This document can also be used by anyone involved with the design and development of joint implementation and Clean Development Mechanism projects, such as: facility energy managers, energy service companies, development banks, finance firms, consultants, government agency employees and contractors, utility executives, city and municipal managers, researchers, and nonprofit organizations.

## 1.5. Scope

LBNL's MERVC guidelines are targeted to energy-efficiency projects that may reduce the generation of energy from fossil fuel sources, thus reducing GHG emissions.[1] The guidelines can be used for assessing the impacts for a single building, or for a group of buildings (e.g., in a program, where there are many participants). These guidelines occupy an intermediate position between a previous report that provided an overview of MERVC issues (Vine and Sathaye 1997) and a procedural handbook that describes the information and requirements for specific measurement and evaluation methods that may be employed for determining energy savings.

The guidelines focus on end-use energy-efficiency projects (see Section 2). The following energy-efficiency projects are not included in this report: (1) improvements in electric generation (e.g., capacity factor improvements and efficiency improvements); (2) improvements in transmission and distribution (i.e., reducing losses in the delivery of electricity or district heat from the power plant to the end user); and (3) efficiency improvements in the transportation sector.

Interventions targeting production or transmission efficiency typically require different monitoring and evaluation techniques than for distributed end-use interventions. For example, because production efficiency projects generally occur at one or a handful of facilities, sampling strategies for monitoring and evaluation are not required to determine GHG emissions impacts. Measurements must be taken at more than one site in order to monitor a single transmission efficiency project. End-use efficiency projects may target just one or two facilities, but sometimes they target a large number of energy consumers, requiring the use of statistical evaluation methods.

LBNL's MERVC guidelines address several key issues, such as: (1) uncertainty and risk; (2) frequency and duration of monitoring and evaluation; (3) methods for estimating gross and net energy savings and emission reductions; (4) verification and certification of GHG reductions; and (5) the cost of MERVC (Vine and Sathaye 1997). We provide a Monitoring and Evaluation Reporting Form and a Verification Reporting Form at the end of this report to facilitate the review of energy-efficiency projects.

LBNL's MERVC guidelines also:

- Address the needs of participants in energy-efficiency projects, including financiers, investors, developers, and technical consultants.
- Discuss procedures, with varying levels of accuracy and cost, for evaluating and verifying (1) baseline and project installation conditions, and (2) long-term energy savings.

[1] A similar set of guidelines has been prepared for forestry projects (Vine et al. 1999).

- Apply MERVC procedures to a variety of projects, including residential, commercial, institutional and industrial facilities.
- Provide techniques for calculating "whole-facility" savings and individual technology savings.
- Provide procedures that (1) are consistently applicable to similar projects throughout all geographic regions, and (2) are internationally accepted, impartial and reliable.

These guidelines reflect the following principles: MERVC activities should be consistent, technically sound, readily verifiable, objective, simple, relevant, transparent, and cost-effective. Sometimes, tradeoffs need to be made for some of these criteria: e.g., simplicity versus technical soundness. Because of concerns about high costs in responding to MERVC guidelines, these guidelines are designed to be not too burdensome. Nevertheless, adequate funding and expertise are necessary for carrying out these activities.

While we have provided checklists for evaluating environmental and socioeconomic impacts, we believe that other existing guidelines are better suited for addressing these impacts (Section 8). The checklists are included to remind project developers and evaluators about the importance of these impacts and the need to examine them during the evaluation of energy-efficiency projects.

We assume that the monitoring, evaluation and reporting activities will be undertaken by project implementors, but that verification and certification will be conducted by an outside third party experienced in verification (see Sections 6 and 7). We do not address which organization is the primary recipient of the information collected in MERVC activities: e.g., a national government, the FCCC Secretariat, or the CDM Executive Board. Nor do we address how this information will be used by these entities: e.g., granting full carbon credits, partial credits, or zero credits, based on the evaluation and verification reports. We expect these issues to be addressed by international bodies in the coming years.

Many of the examples described in these guidelines are based on the experience of evaluating energy-efficiency projects and programs in North America. Historically, more resources have been available for conducting MERVC activities in North America than in other countries. Although developing countries, for example, may not presently have the resources to conduct these activities, we believe that all participants implementing and evaluating energy-efficiency projects for climate change mitigation should conduct one or more of the methods proposed in these guidelines. We hope that developed countries will support the use of these methods in developing countries, as part of capacity building and technology transfer. Due to the scarcity of evaluations of energy-efficiency projects in other countries, we hope that resources are made available for preparing these studies so that we can obtain a better understanding of the evaluation experience and capabilities in these countries.

Finally, the Kyoto Protocol contains emission targets, differentiated by country, for an aggregate of six major greenhouse gases (measured in carbon equivalents): carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride ($SF_6$). These guidelines only examine MERVC issues dealing with $CO_2$.

## 1.6. Relationship to Other Programs/Documents

In a previous paper, we reviewed existing guidelines and protocols related to GHG reductions (Vine and Sathaye 1997). We concluded that while one or more of these documents addressed many of the issues that need to be covered in MERVC guidelines, none of them provided the type of detailed, standardized guidelines needed for addressing all of the issues in this report. Nevertheless, as noted below, LBNL's MERVC guidelines are indebted to the information and guidance contained in these documents.

**1.6.1. International Performance Measurement and Verification Protocol**. The U.S. Department of Energy's International Performance Measurement and Verification Protocol (IPMVP) is a consensus document for measuring and verifying energy savings from energy-efficiency projects (Kats et al. 1996 and 1997; Kromer and Schiller 1996; USDOE 1997). For LBNL's MERVC guidelines, the IPMVP is the preferred approach for monitoring and evaluating energy-efficiency projects for climate change mitigation (see Section 3.2.8).

**1.6.2. U.S. Federal Energy Management Program.** The U.S. Department of Energy's Federal Energy Management Program (FEMP) was established, in part, to reduce energy costs to the U.S. Government from operating Federal facilities. FEMP assists Federal energy managers by identifying and procuring energy-efficiency projects. Part of this assistance included the development of an application of the International Performance Measurement and Verification Protocol (IPMVP), for the U.S. Federal sector, which is called the FEMP Guidelines (USDOE 1996).

**1.6.3. U.S. EPA Conservation Protocols**. The U.S. Environmental Protection Agency's Conservation Verification Protocols are designed to verify electricity savings from utility demand-side management programs for the purpose of awarding sulfur dioxide allowances under EPA's Acid Rain Program (Meier and Solomon 1995; USEPA 1995 and 1996). LBNL's MERVC guidelines have incorporated aspects of EPA's guidelines.

**1.6.4. U.S. ASHRAE GPC 14P**. LBNL's MERVC guidelines are complementary to the work of the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) GPC 14P Committee that is currently writing guidelines for the measurement of energy and demand savings.

When completed, these guidelines will be used to modify the IPMVP. In contrast to the ASHRAE document, which focuses on the relationship of the measurement to the equipment being verified at a very technical level, LBNL's MERVC guidelines are more general and discuss a variety of topics as they relate to monitoring, evaluation, reporting, verification, and certification.

**1.6.5. World Bank's monitoring and evaluation guidelines**. The World Bank prepared monitoring and evaluation guidelines for the Global Environment Facility (GEF), a multilateral funding program created to support projects that yield global environmental benefits but would not otherwise be implemented because of inadequate economic or financial returns to project investors (World Bank 1994). The GEF supports four types of projects: biodiversity preservation, pollution reduction of international waters, GHG emission reduction and, to a limited extent, the control of ozone-depleting substances. LBNL's MERVC guidelines have incorporated aspects of the World Bank guidelines.

**1.6.6. USIJI's Project Proposal Guidelines.** The U.S. Initiative on Joint Implementation (USIJI) prepared project proposal guidelines for organizations seeking funding from investors to reduce GHG emissions (USIJI 1996). The guidelines request information on the proposed project, including the identification of all GHG sources included in the emissions baseline as well as those affected by the proposed project, and net impacts. The guidelines also ask for additional information, such as the estimates of GHG emissions, including methodologies, type of data used, calculations, assumptions, references and key uncertainties affecting the emissions estimates. The estimates include the baseline estimate of emissions of GHG without measures and the estimate of emissions of GHG with measures. LBNL's MERVC guidelines have incorporated many aspects of the USIJI's guidelines.

**1.6.7. DOE's Voluntary Reporting of Greenhouse Gases.** The U.S. Department of Energy (DOE) prepared guidelines and forms for the voluntary reporting of greenhouse gases (USDOE 1994a and 1994b). The guidelines and forms can be used by corporations, government agencies, households and voluntary organizations to report to the DOE's Energy Information Administration on actions taken that have reduced emissions of greenhouse gases. The documents offer guidance on recording historic and current GHG emissions and emissions reductions. The supporting documents (USDOE 1994b) contain limited examples of project analysis for the following sectors: electricity supply, residential and commercial buildings, industrial, transportation, forestry, and agriculture. Companies are allowed discretion in determining the basis from which their emissions reductions are estimated and can self-certify that their claims are accurate. LBNL's MERVC guidelines have incorporated aspects of DOE's guidelines.

**1.6.8. California's Measurement and Evaluation Protocols.** Protocols and procedures for the measurement and evaluation of California's utility energy-efficiency programs were developed in response to the shareholder earnings mechanisms established for the four largest investor-owned utilities to acquire demand-side resources (CPUC 1998). The protocols are targeted to the evaluation

of programs, rather than an individual building, and have very detailed requirements. LBNL's MERVC guidelines are more flexible than the California protocols, but have incorporated some components of the protocols (e.g., quality assurance guidelines—see Section 4.2.10).